Appendix C

Possible Treatment Methods Available, Life Cycle, and Mode of Reproduction for Known Established, New, and Potential Invaders of Weed Species on or Adjacent to the Salmon-Challis National Forest

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Common Name	Scientific Name	Life Cycle	Modes Of Reproduction	Biocontrol Agents	Herbicide	Cultural (Restoration) Methods	Mechanical Methods (Includes Grazing)
ESTABLISHED INVADERS							
Whitetop (Hoary cress)	*Cardaria draba*	Perennial	Seeds (viable 3 years) and deep creeping roots.	None currently available.	• glyphosate • 2,4-D • chlorsulfuron • metasulfuron New potentially effective: WOW and Scythe.	Presence of competing vegetation, particularly shrubs, vetch, lupine, and other nitrogen-fixing legumes.	Mowing or grazing with sheep or goats during bud stage and again during rebud (follow by herbicide). Hand-pulling or digging must remove all roots and continue for 2 to 5 years to eradicate.
Musk thistle	*Carduus nutans*	Biennial or winter annual	Seeds (prolific seed producer, seeds viable up to 10 years).	• rosette weevil (*Trichosirocalus horridus*) • flea beetle (*Psylliodes chalcomera*) • syrphid fly (*Cheilosia corydon*) • thistle-defoliating beetle (*Cassida rubiginosa*) [The seedhead weevil (*Rhinocyllus conicus*) is not recommended because it attacks some native, rare thistles.]	• glyphosate • 2,4-D • dicamba • piclorarn • metsulfuron methyl • clopyralid • 2,4-D amine + • glyphosate + 2,4-D New potentially effective: WOW and Scythe.	Revegetation for shade.	Mowing before flowering, continuously. Cutting plant below crown.

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Spotted knapweed	*Centaurea maculosa*	Biennial or short-lived perennial	Seeds, lateral shoots.	• seed head gall fly (*Urophora affinis*) • seed head gall fly (*U. quadrifasciata*) • seed head moth (*Metzneria paucipunctella*) • black leaf blight fungus *(Alternaria alternata*) • root moth (*Agapeta zoegana*) • verdant seed fly (*Terellia virens*) • root weevil (*Cyphocleonus achates*)	• glyphosate • picloram • 2,4-D • clopyralid + 2,4-D • dicamba clopyralid (not recommended for sites with other weed species) New potentially effective: WOW and Scythe.	Revegetation for shade. Regular cultivation/ seeding. Spring burning.	Hand-pulling of small infestations (usually takes 7 to 10 years).
Canada thistle	*Cirsium arvense*	Perennial	Seeds, shoots from lateral roots (dormant, buried seeds can remain viable for up to 26 years).	• stem-boring beetle (Ceutorhyncus litura) • gall fly (Urophora cardui) • shoot fungus (Sclerotinia sclerotiorum)	• 2,4-D • clopyralid + 2,4-D • clopyralid • dicamba New potentially effective: WOW and Scythe.	Revegetation for shade. Cultivation not recommended.	Removing flowers to prevent seed production.

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Bull thistle	*Cirsium vulgare*	Biennial	Seeds.	• gall fly (*Urophora stylata*)	• picloram New potentially effective: WOW and Scythe.	Revegetation for shade (the presence of tall herbs reduces bull thistle seedling survival. When grass growth was reduced by herbicide spraying, bull thistle increased in frequency).	Hand-pulling, mowing, burning, digging will kill if aboveground portions of the plant are completely removed or consumed because It does not sprout from the root crown or root. If 8 inches or more of stem remains alive, it may sprout from remaining portions of the stem.
Leafy spurge	*Euphorbia esula*	Perennial	Seeds, spreading roots.	• flea beetle (*Aphthona abdominalis*) • flea beetle (*Aphthona nigriscutis*) • hawk moth (*Hyles euphorbiae*)	• glyphosate • dicamba • picloram • glyphosate + 2,4-D • piclorarn + 2,4-D	Seeding with sod-forming perennials. Fall burning.	Mowing/cutting before flowering. Cultivation every 14 days. Hand-pulling of small infestations before seed production. Grazing with sheep or goats.
Black henbane	*Hyoscyamus niger*	Annual or biennial	Seeds (seeds viable for 4 years).	None currently available.	• glyphosate		Hand-pulling, mowing, or digging to prevent seed production, must remove tap root to kill the plant. Burning mature plants will kill the seed. Regular cultivation. Toxic to livestock, including sheep.

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Cheatgrass	*Bromus tectorum*	Winter annual	Seeds.	None currently available. [Two rhizobacteria, *Pseudomonas fluorescens* (strain D7), and *Pseudomonas syringae* (strain 3366) are under study.]	Spring: • glyphosate Apply in early spring when the plants were 10 cm (3.9 in) high or less and growing vigorously. Fall: • sulfometuron methyl • Apply after fall germination. New potentially effective: WOW and Scythe.	Must revegetate sites that have been disked or sprayed to provide competition.	Cutting is not recommended. Deep disking several times at intervals to bury seeds 4 to 6 inches then overseeding. Shallow disking to initiate seed germination, then either disking again or spraying with glyphosate, followed by broadcast or drill seeding.
Common mullein	*Verbascum thapsus*	Biennial or short-lived perennial	Seeds (one plant can produce 100,000-180,000 seeds with viability up to 100 years).	• mullein seedhead weevil (*Gymnetron tetrum*) Pending approval: mullein moth (*Cucullia verbasci*).	• glyphosate New potentially effective: WOW.	Chickens are successful at eradicating. Cattle and sheep avoid it so decreasing livestock utilization can help native vegetation compete.	Easy to pull in loose soils because of shallow taproot (before flowering). Hand-hoeing or digging also effective. Mow or scythe just before flowering.

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NEW INVADERS							
Hoary alyssum	*Berteroa incana*	Annual, biennial, or short-lived perennial	Seeds.	None currently available.	• glyphosate • 2,4-D New potentially effective: WOW and Scythe.	Presence of competing plants. Seeding and fertilizing.	Hand-pulling or digging.
Russian knapweed	*Centaurea repens* or *Acroptilon repens*	Long-lived perennial (75 years)	Rhizomes (new shoots arise from creeping roots, up to 27 root shoots/ft^2 and roots can reach depths to 23 feet). Relatively few seeds are produced (viable for 2-3 years).	• gall-forming nematode (*Subanguina picridis*) • seed head gall fly (*U. quadrifasciata*) • seed head gall fly (*Urophora affinis*)	• picloram • clopyralid • glyphosate	The healthier the native vegetation, the less susceptible it will be to Russian knapweed invasion. (Once established, it emits allelopathic compounds to inhibit other plants).	Cultivation, cutting/mowing, and/or hand-pulling not recommended unless done three times per year (spring, summer, fall) to force the plants to use nutrient reserve stored in roots, followed by herbicide treatment. This protocol must be followed for at least 3 years otherwise it will stimulate sprouting from rhizomes. It is difficult to remove all roots with a one-time effort. Severed root pieces as small as 2.5 cm can generate new shoots from depths to 15 cm.

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Rush skeletonweed	*Chondrilla juncea*	Perennial	Seeds, lateral roots and root fragments.	• gall midge (*Cystiphora schmidti*) • gall mite (*Eriophyes chondrillae*) • rush skeletonweed rust (*Puccinia chondrillina*)	Difficult to control with herbicides. Takes consistent spraying for 3 to 5 years. • 2,4-D • picloram • clopyralid + • dicamba	Heavy seeding rates and fertilizing with nitrogen works best.	Hand-pulling must remove all roots (3 to 6 times per year for 6 to 10 years to eradicate new shoots and seedlings). Mowing not recommended (increase growth from roots). Cultivation and/or digging, if within 5 weeks after germination.
Houndstongue	*Cynoglossum officinale*	Biennial	Seeds, attach to fur and clothing.	None currently available.	• picloram • dicamba (Apply at rosette stage, late summer or early fall.)	Keep and maintain vigorous vegetative cover.	Hand-pull before flowering.
St. Johnswort	*Hypericum perforatum*	Perennial	Seeds and rhizomes.	• beetle (*Agrilus hyperici*) • moth (*Aplocera plagiata*) • beetle (*Chrysolina hyperici*) • beetle (*Chrysolina quadrigemina*) • Klamath weed midge (*Zeuxidiplosis giardi*)	• 2,4-D • picloram (spring) • glyphosate (spring) • metsulfuron methyl Repeated applications necessary.	Maintain competitive, closed-canopy plant community. This species is not shade tolerant.	Hand-pulling or digging of young, isolated plants. Cutting and mowing not recommended, may reduce seed but promotes sprouting from rhizomes. Regular cultivation.
Dyer's woad	*Isatis tintoria*	Winter annual, biennial, or short-lived perennial	Seeds.	• rust (*Puccinia thlaspeos*) [Occurs naturally, not currently approved.]	• 2,4-D • chlorsulfuron		Hand-pulling, cultivation, or digging below the crown before seed production are very effective, must remove crown to prevent resprouting.

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Dalmatian toadflax	*Linaria genistifolla ssp. delmatica*	Perennial	Seeds, vegetative growth from lateral root buds (seeds viable 10-15 years).	• toadflax moth (*Calophasia lunula*) • root-boring moths (*Eteobalia intermediella and E. serratella*) • seed capsule-feeding weevils (*Gymnetron antirrhini and G. linariae*) • stem-boring weevil (*Mecinus janthinus*) • ovary-feeding beetle (*Brachypterolus pulicarius*)	Waxy coat typically makes this method ineffective. Two stages of vulnerability: fall rosette stage or when flowering, so root reserves are lower: • glyphosate • dicamba • picloram The preemergent WOW may also be effective.	Toadflax seedling are initially very vulnerable to competition from established, vigorous vegetation. Restrict spring cattle grazing on sites with toadflax to maintain vigorous competition from native species.	Hand-pulling must remove all roots, best in sandy or moist soils (annually, 10 to 15 years to eradicate). Regular cultivation (every 7 to 10 days starting in June, for 2 years). Do not mow.
Yellow toadflax	*Linaria vulgaris*	Perennial	Seeds and creeping lateral roots (seeds viable 10-15 years).	• toadflax moth (*Calophasia lunula*) • root-boring moths (*Eteobalia intermediella* and *E. serratella*) • seed capsule-feeding weevils (*Gymnetron antirrhini* and *G. linariae*) • stem-boring weevil (*Mecinus janthinus*) • ovary-feeding beetle (*Brachypterolus pulicarius*)	• glyphosate (See Dalmatian toadflax.)	Intense competition with native vegetation. Restrict spring cattle grazing on sites with toadflax to maintain vigorous competition from native species.	Hand-pulling must remove all roots (annually, 10 to 15 years to eradicate). Regular cultivation. Do not mow.

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Scotch thistle	*Onopordum acanthium*	Biennial	Seeds.	• seed-head weevil (*Rhinocyllus conicus*) • thistle crown-weevil (*Trichosirocalus horridus*)	• glyphosate • picloram • dicamba • 2,4-D • 2,4-D + dicamba	Establish and maintain dense, vigorous native vegetation, especially important to have vegetative cover in the fall when seeds germinate (adjust grazing regimes to avoid late summer/fall rotations).	Digging must cut plant off below soil level, leaving no above-ground biomass.
Sulfur cinquefoil	*Potentilla recta*	Perennial (long-lived)	Seeds (broken roots can regenerate).	• root moth (*Tinthia myrmosae-formis*) • flower-head weevil (*Anthonomus rubripes*)	• picloram (fall) • 2,4-D (spring, rosette stage)	Regular cultivation and reseeding.	Hand-pulling of small infestations (must remove root crown). Regular cultivation. Mowing not recommended.

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Tansy ragwort	*Senecio jacobaea*	Biennial (rarely annual or perennial)	Seeds (viable for several years) and can regenerate top-growth when cut.	• seed fly (*Pegohyllemyia seneciella*) • flea beetle (*Longitarsus jacobaeae*) • cinnabar moth (*Tyria jacobaeae*)	• 2,4-D • picloram • dicamba • 2,4-D + dicamba • metsulfuron methyl • clopyralid • clopyralid + 2,4-D Spring is usually the best time to spray.	The healthier the native vegetation, the less likely this plant will become established (needs disturbance to create openings in native vegetation in order to establish).	Mowing just prior to flowering when the plant has exhausted the greatest amount of its stored reserves and before its seeds have started to develop. Although mowing can prevent flowering, it appears to increase rosette density. Hand-pulling small infestations before flowering must remove all roots. Grazing heavy infestations with sheep prior to flowering.
Common tansy	*Tanacetum vulgare*	Perennial	Seeds, rhizomes.	None currently available.	• dicamba + • picloram • metsulfuron methyl	Revegetation for shade.	Hand-pulling not recommended (stimulates sprouting from rhizomes) and must remove all roots. Constant cultivation, otherwise the infestation can increase infestation by chopping roots that sprout. Mowing to reduce seed production. Grazing by sheep and goats.
Field pennycress	*Thlaspi arvense*	Annual/ winter annual	Seeds	None known.	• glyphosate • WOW	Revegetation after site disturbance.	Mowing to reduce seed production. Fall tillage.

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Bur buttercup	*Ranunculus testiculatus*	Annual	Seeds.	None known.	• glyphosate	Establish and maintain healthy native vegetation.	Hoeing or cultivation before seeds form.
Blue mustard	*Chlorispera tenella*	Annual/ winter annual	Seeds	None known.	• glyphosate	Revegetation after site disturbance.	Cultivation/tillage in early spring. Mowing in early flowering period.

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POTENTIAL INVADERS							
Jointed goatgrass	*Aegilops cylindrica*	Winter annual	Seeds (viable in soil up to 6 years).	None known.	• glyphosate	Establish and maintain native vegetation.	Spring tillage or hand removal for small outbreaks.
Skeletonleaf bursage	*Ambrosia tomentosa*	Perennial	Seeds and deep creeping rhizomes.	None currently available.	• 2,4-D • picloram		Avoid disking or cultivating as it spreads root fragments.
Diffuse knapweed	*Centaurea diffusa*	Biennial or short-lived perennial	Abundant seed production.	• seed head gall fly (*Urophora affinis*) • seed head gall fly (*U. quadrifasciata*) • peacock fly (*Chaetorellia acrolophi*) • seed head weevil (*Bangasternus fausti*) • root weevil (*Cyphocleonus achates*) • root moth (*Agapeta zoegana*)	• glyphosate • picloram • 2,4-D • clopyralid • clopyralid + 2,4-D • dicamba	Revegetation for shade. Spring burning.	Hand-pulling of small infestations (usually takes 7 to 10 years).
Meadow knapweed	*Centaurea pratensis*	Perennial	Seeds.	• seed head gall fly, (*Urophora quadrifasciata*)	• glyphosate • 2,4-D • picloram • clopyralid	Establish and maintain good vegetation, particularly perennial grasses.	Hand-pulling is effective. Cultivation must be repeated several times a year for several years.

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Yellow starthistle	*Centaurea solstitialis*	Winter annual or biennial	Seeds (up to 10 years dormancy and viability).	• seed head weevil (*Bangastemus orientalis*) • peacock fly (*Chaetorellia australis*) • flower weevil (*Larinus curtus*) • yellow starthistle hairy weevil, (*Eustenopus villosus*) • flies (*Urophora sirunaseva and U. jaculata*) (All of the above are approved.) • false peacock fly (*Chaetorellia succinea*) (Effective, but waiting for final approval.)	• glyphosate • picloram • *clopyralid* • 2,4-D amine + • clopyralid	Revegetation with native species for shade.	Mowing, burning early in flower (timing is critical). Grazing before spine production (toxic to horses). (Hard to control seed ban with mechanical methods.)
Poison hemlock	*Conium maculatum*	Biennial, winter annual, or rarely perennial	Seeds.	• defoliating moth (Agonopterix alstroemeriana)	• glyphosate • 2,4-D • hexazinone • metribuzin • tebuthiuron	Establish and maintain healthy native vegetation.	Frequent low mowing or cutting (no grazing, poisonous to livestock). Hand-pulling (gloves) or cultivating works well, continue as long as viable seed remains in seed bank.

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Field bindweed	*Convolvulus arvensis*	Perennial	Seeds (viable up to 50 years) and creeping deep roots.	• leaf-galling mites (*Aceria malherbae / A. convolvuli*)	• glyphosate • 2,4-D + dicamba • picloram • metsulfuron	Establish and maintain healthy native vegetation, especially perennial grasses.	Hand-pulling (and cultivating) must be done for 3 to 5 years every 2 weeks to be effective. Neither grazing nor mowing are effective controls.
Common crupina	*Crupina vulgaris*	Winter annual	Seeds (viable 3 years or less).	None known.	• glyphosate • 2,4-D + dicamba	Establish and maintain healthy native vegetation (must revegetate after removal).	Preventing all seed production for at least two generations (hand-pulling, plowing, and hoeing).
Scotch broom	*Cytisus scoparius*	Woody perennial	Seed, some sprouting (seeds remain viable in soil for up to 80 years).	None have proven effective in Idaho.	• 2,4-D • triclopyr ester • picloram + 2,4-D	Revegetation for shade.	Hand-pulling (must be repeated for many years due to long dormancy of seed in soil). Grazing with goats (or chickens).
Toothed spurge	*Euphorbia dentata*	Annual	Seeds.	None currently available.	• glyphosate	Reduce disturbance. Change grazing regime to allow native species to thrive.	Hand-pulling or grubbing is effective.
Meadow hawkweed	*Hieracium pratense*	Perennial	Seeds (wind-adapted), stolons, and rhizomes.	None currently available.	• glyphosate • 2,4-D + picloram • clopyralid • dicamba + 2,4-D [Spray in spring before bloom.]	Revegetation for shade by seeding and fertilization. Annual cultivation.	Hand-pulling not recommended (stimulates sprouting from rhizomes) must remove all roots.

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Orange hawkweed	*Hieraclum aurantiacum*	Perennial	Seeds (wind-adapted), stolons, and rhizomes.	None currently available.	• 2,4-D + picloram • glyphosate • clopyralid • dicamba + 2,4-D • Spray in spring before bloom.	Revegetation for shade by seeding and fertilization. Annual cultivation.	Hand-pulling not recommended (stimulates sprouting from rhizomes) difficult to remove all roots.
Perennial pepperweed	*Lepidium latifolium*	Perennial	Seeds and creeping roots.	None approved.	• chlorsulfuron • imazapyr [Should be applied at flower-bud stage.]	Establish and maintain healthy riparian vegetation.	Fall-disking, spring mowing, followed by herbicides, including glysophates has some good results.
Purple loosestrife	*Lythrum salicaria*	Perennial	Seeds and rhizomes.	• weevil (*Hylobius transversovittatus*) • black-margined and golden leaf eating beetles (*Galerucella calmariensis* and *G. pusilla*) • flower weevil (*Nanophyes marmoratus*)	• glyphosate (When plants begin to flower.) [Rodeo™ has approval for wetlands.] [3]	Revegetation can be effective.	Hand-pulling or cutting before flowering, followed immediately by flooding (general mowing or cutting not recommended).
Milium	*Milium vernale*	Winter annual	Seeds.	None currently available.	• glyphosate • chlorsulfuron	Revegetation is effective.	Spring plowing.

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Eurasian watermilfoil	*Myriophyllum spicatum*	Perennial	Produces seeds (rarely), but prolifically spread by runners and autofragments.	• native midge (*Cricotopus myriophylli*) • weevil (*Euhrychiopsis lecontei*) • caddisfly (*Triaenodes tarda*)	(Plant die-off from spraying has caused fish die-off because of oxygen depletion in water.)		Water draw-downs in reservoirs prior to freezing temperatures can expose the plant and kill it. Cover small patches with opaque fabric, such as burlap.
Matgrass	*Nardus stricta*	Perennial	Seeds.	None known.	• glyphosate		
Silverleaf nightshade	*Solanum elaeagnifolium*	Perennial	Seeds and spreading rhizomes.	None known.	• glyphosate picloram • imazapyr	Establish dense canopy-forming vegetation.	Cultivation must be frequent and thorough or will spread. Cutting and mowing ineffective.
Buffalo bur	*Solanum rostratum*	Annual	Seeds.	None known.	• glyphosate	Establish and maintain healthy native vegetation, particularly important to limit heavy grazing.	Avoid methods that disturb the soil.
Perennial sowthistle	*Sonchus arvensis*	Perennial	Seeds (2-5 year viability), and spreading, thickened horizontal roots (rhizomes).	• cyst-forming nematode (*Heterodera sonchophila*) • seedhead fly (*Tephritis dilacerata dilacerata*) (Waiting for final approval.)	• glyphosate • clopyralid • dicamba • 2,4-D • amitrol (Herbicides not very effective for this species.)	Establish and maintain healthy native vegetation.	Cutting, grazing, and mowing can be effective at depleting root stores, if done selectively and frequently. Hoeing and cultivating can be effective if done at 6-leaf rosette stage.

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Johnsongrass	*Sorghum halepense*	Perennial	Seeds and rhizomes.	None known.	• glyphosate (Must be used together with mechanical to be effective.)	Establish and maintain native vegetation.	Repeated mowing or grazing to reduce rhizome vigor followed by herbicide. Repeated and continuous tillage (do not till at all if cannot repeat continuously).
Puncturevine	*Tribulus terrestris*	Annual	Seeds (viable in soil 4-5 years).	• weevils (*Microlarinus lareynii* and *M. lypriformis*)	• glyphosate • picloram	Establish and maintain native vegetation.	Repeated cultivation. Neither mowing or grazing is effective.
Syrian bean caper	*Zygophyllum fabago*	Perennial	Seeds and lateral roots and root pieces.	None known.	Leaf surfaces are smooth and waxy, making herbicide control difficult.		Hand-pulling of entire root system.

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[1]Approved for release 4/4/97; USFWS concurrence pending.

[2]Approved for release 6/17/98; USFWS concurrence pending.

[3] Spot application of Rodeo™ directly onto *L. salicaria* would ensure that no large holes would appear in the marsh vegetation and that competition would be unaffected. The safest method of applying glyphosate herbicide is to cut off all stems at about 6 inches and then paint or drip onto the cut surface a 20-30% solution (Henderson 1987).

[Int]Must use integrated weed management approach to successfully eradicate this species.

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